NASA Innovative Advanced Concepts

Heliopause Electrostatic Rapid Transit System (HERTS)

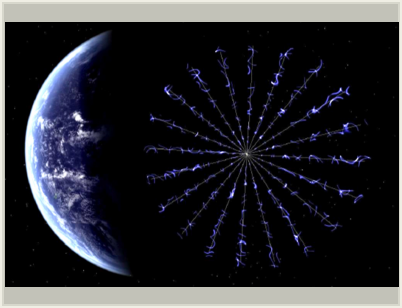
Completed Technology Project (2015 - 2017)

Project Introduction

Our proposal builds upon our teams technical findings in Phase 1 - that an E-Sail propelled spacecraft can travel 100 AU in less than 10 years or to the Heliopause (120 - 150 AU) in < 15 years. In addition to the Heliopause missions, our team member - Dr. Pekka Janhunen of the Finish Meteorological Institute (FMI) - has examined a number of missions of scientific discovery where the E-Sail propulsion system will provide rapid transits so various researchers could begin to get data back from outer planetary missions within 1 to 2 years of launch.

Anticipated Benefits

The proposed HERTS Phase II study will move us forward in the quest to make rapid heliospheric transit times a reality. From the Phase I and previous top-level studies, HERTS appears feasible. The Phase II study will determine its functional and engineering feasibility and bring us to the point of a preliminary system design. The available model presently being used for performance calculations is well-known, but its application to this particular problem is questionable. The proposed experimental program and theoretical calculations using a numerical PIC code will combine to validate a working model capable of providing reliable and accurate engineering design parameters. This will, in turn, enable a realistic preliminary design that can be used to provide accurate HERTS performance metrics for a range of solar wind conditions and transfer times for a variety of missions, mature HERTS deployment and operational scenarios; and mature the design of physical components and the overall HERTS system to the level necessary for a flight validation test. The Phase II study is designed to close the gap on the TRL of the major risk areas. Phase II will provide NASA with the design knowledge and tools to begin development of a functioning propulsion system. The plasma testing and PIC modeling will provide the data to define the power requirements and operating voltage levels needed to provide the vehicle with the required thrust/acceleration. The wire configuration and design task will provide a workable design that will allow the team to focus resources to mature the design and proposed meaningful tests to reduce the technical and operational risk of the deployment and wire configurations. Vehicle control is critical to allowing the spacecraft to navigate to regions of deep space that are of interest. The product of the Phase II study will provide algorithms and methods to manage the vehicle and to design voltage control strategies for steering the vehicle. The final task will provide NIAC program with a set of recommendations to mature the propulsion system and provide NASA with a means to explore the Heliopause on a time scale that will interest scientists and provide a propulsion system that may allow the development of deep space Cubesats to explore the rest of our solar system. The team expects to publish several conference papers as a result of this study. The PIC modeling could improve the understanding of spacecraft charging in any deep space environment. The plasma testing and PIC modeling provide a basis to validate PIC modeling



Artist rendering of Heliopause Electrostatic Rapid Transit System

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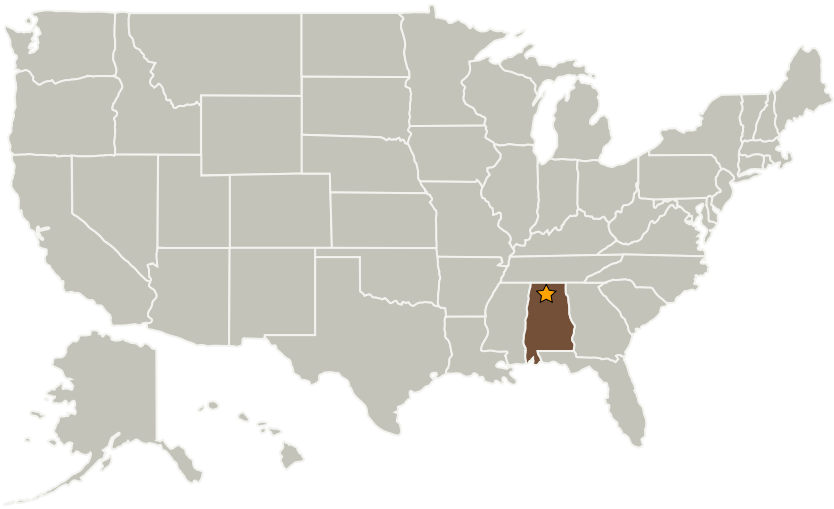
approaches with domain specific data.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Marshall Space Flight Center(MSFC)	Lead Organization	NASA Center	Huntsville, Alabama
Finnish Meteorological Institute	Supporting Organization	Academia	Helsinki, Outside the United States, Finland
Tethers Unlimited Inc	Supporting Organization	Industry	

Primary U.S. Work Locations
Alabama

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Marshall Space Flight Center (MSFC)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Bruce M Wiegmann

Co-Investigators:

Pekka J Janhunen
Robert W Schunk
Nobie H Stone
Robert Hoyt

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Project Transitions

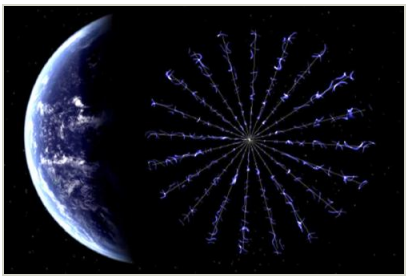
July 2015: Project Start

June 2017: Closed out

Closeout Summary: The MSFC Education Office under Dr. Frank Six has also a warded two small grants ($2000 each) to the University of Alabama (Fall 2017 & Spring 2018) to investigate possible cutting edge space tether materials and the University of Kentucky (Spring & Fall of 2018) to investigate tether deployer bra king systems.

Closeout Link: https://www.nasa.gov/feature/heliopause-electrostatic-rapid-transit-system-herts

Images



Project Image
Artist rendering of Heliopause Electrostatic Rapid Transit System
(https://techport.nasa.gov/image/102124)

Links

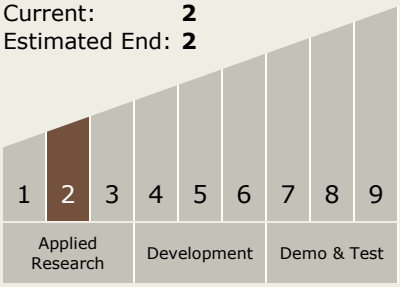
NASA.gov Feature Article
(https://www.nasa.gov/feature/heliopause-electrostatic-rapid-transit-system-herts)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **2**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.4 Advanced Propulsion
    - TX01.4.4 Other Advanced Propulsion Approaches

Target Destination

Outside the Solar System